Saxony.—K. Sachs. Met. Institut. *Das Klima des Konigreiches Sachsen.* Heft III. 4to. Chemnitz. 1895. 65 pp.

South Australia.—Adelaide Observatory. *Meteorological observations made at the Adelaide Observatory and other places in South Australia and the northern territory during the year* 1883, 277 pp.; in 1888, in 3 sections, 136 pp.; 1893, 4 sections, 170 pp. Adelaide. 1896.

Switzerland.—Annalen der Central-Anstalt, 1893. *Der Schweizerischen met. beobachtungen.* Zurich. 1895.

United States Hydrographic Office.—*Sailing directions on Lake Michigan, Green Bay, and Straits of Mackinaw.* No. 108. Part II. 139 pp. 8vo. *Lake Huron and Detroit River.* Part III. 109 pp. 8vo.

United States Hydrographic Office.—*Sailing directions for the Gulf Coast of the United States, Caribbean Sea and Gulf of Mexico.* Supplement No. 2. 71 pp. 8vo. 1891.

Wisconsin University.—*Annual Report of the Agricultural Experiment Station.* Vol. XII. 349 pp. 8vo. Madison. 1895.

THE TORNADO OF MAY 27 AT ST. LOUIS, MO.

By H. C. FRANKENFIELD, Local Forecast Official. (Seventy-fifth meridian time has been used throughout this report.)

The tornado which passed through St. Louis late in the afternoon of May 27 was the culmination of a protracted period of abnormally high temperatures, intensified during the latter portion of the time by unusually high humidity. From April 9 to May 27, both inclusive, a period of forty-nine consecutive days, the mean temperature at St. Louis varied from 2° to 21° above the normal. The mean temperature for the month of April was 8° above the normal, and 4° higher than any previous record in the history of the Weather Bureau station in St. Louis. The mean temperature for the month of May was 7° above the normal, and 1.5° higher than any previous record.

The relative humidity was almost exactly normal during April, while during May it was 74 per cent, or 8 per cent more than the normal amount. From May 14 to May 27 it was continuously high at 8 a. m., the average for the period of fourteen days being 88 per cent, or 14 per cent more than the normal amount for that time of the day.

Again, with the exception of three days, the barometric pressure throughout the West for the seven weeks previous to May 27 had been below the normal, with relatively higher pressure in the East and Southeast. Before one depression would disappear in the West another would be seen waiting to take its place. This constant succession of low areas caused the winds to blow persistently from a southerly direction, carrying with them heat and moisture. During April southerly winds prevailed at St. Louis during 69 per cent of the time, and during May during 78 per cent of the time. The bricks and stones in the buildings and streets thus became an enormous storehouse of heat, free radiation at night being prevented by smoke and dust.

At 8 a. m., May 27, the weather map showed the pressure to be low throughout the West, except in the extreme northwest, with the center of depression covering Kansas and Nebraska, the inner isobar being drawn for 29.70 inches. The State of Missouri was, therefore, in the southeast quadrant of the low area. Clear weather, with southerly winds, prevailed through Kansas, Oklahoma, Missouri, and Arkansas, with temperatures ranging from 66° to 78°. The relative humidities were abnormally high, particularly so in Missouri, that at St. Louis being 94 per cent. From Kansas and Nebraska eastward the isotherms of 60° and 70° crossed the isobars at right angles. The position of the State of Missouri in the southeast quadrant of the storm area, combined with the isothermal conditions above mentioned, the high humidity, and the high temperatures, indicated the occurrence of severe local storms within a short time. At St. Louis at 8 a. m. the pressure was 29.92 inches, the temperature 70°, and the relative humidity 94 per cent. The winds were blowing from the south, with a velocity of 8 miles per hour, and the sky was about one-third covered with cumulo-stratus clouds, with some traces of cirro-stratus, both moving from the southwest. By noon the barometer had fallen .05 inch, to 29.87, and the temperature had risen to 80°. The winds remained mostly in the south, with a slightly increased velocity, reaching 12 miles at noon. The abnormally high humidity continued, and the sky became hidden by a uniform covering of alto-stratus clouds, through which the sun shone lazily, not enough to glare uncomfortably, but still sufficiently to cast a well-defined shadow.

From noon until 1.45 p. m. the barometer remained stationary and the winds shifted slightly to the southwest, averaging from 7 to 10 miles per hour. The temperature rose to 86°, and the veil of alto-stratus clouds still hung over the city. By 2 p. m. the barometer had commenced to fall rapidly, and the winds had changed to southeast, with slowly increasing velocity. The fall in pressure was intermittent, but at the same time persistent, and by 6 p. m. the reading was 29.59 inches, a fall of 0.28 inch since noon, and a fall of 0.09 inch during the twenty minutes immediately preceding. The winds continued from the southeast with gradually increasing velocity until 5.45 p. m., when they changed to east-northeast with a sudden increase in velocity, reaching 45 miles per hour from 5.55 to 6 p. m.

At 3.45 p. m. the temperature commenced to fall, and by 6 p. m. had fallen 9°, to 77°. The clouds slowly increased in density, and at 3.35 p. m. the sun was obscured. The character of the clouds changed about this time to cumulus, but of a very peculiar formation. The whole sky was compactly covered with small cumuli of almost perfect hemispherical shape, but with the rounded portions underneath.* Their color was a dark gray with deep shadows on the sides farthest from the sun. By 4.30 p. m. these clouds had settled into a uniform covering of stratus, which commenced to assume a light green color in the extreme northwest, spreading more toward the west and north. Thunder and lightning commenced at 5.06 p. m., and rain in the form of large, scattered drops, at 5.43 p. m. At 6.04 p. m. there was a marked increase in the violence of the storm, although from 6 to 6.10 p. m. the winds changed again to southeast, with decreased velocity of from 33 to 36 miles per hour. During this period the barometer rose 0.08 inch, to 29.67, and fell almost instantly 0.10 inch, to 29.57. It again rose 0.10 inch in less than five minutes, to 29.67. During the next fifteen minutes (to 6.30 p. m.), it fell 0.31 inch, to 29.36, and then instantly rose 0.40 inch, to 29.76. It then continued in a series of sharp oscillations of from 0.05 to 0.10 inch, until 10 p. m., when the oscillations became smaller, ceasing finally at midnight, when a steady rise commenced.†

The winds at 6.10 p. m. once more changed suddenly, this time 180° to the northwest, and with greatly increased velocity, reaching 80 miles per hour from 6.15 to 6.20 p. m., with an extreme velocity of 120 miles per hour at 6.18 p. m. At

* Mammato-cumulus. See in this connection the REVIEW of March, 1894. Mr. J. C. Widmeyer, observer, Weather Bureau, Oklahoma, Okla., has also noticed the same cloud formation on days when tornadoes formed in the Territory. No special significance seems to attach to the phenomena, except that of a gradual descent or sinking of the air.

† Note added by Mr. Frankenfield, June 23, 1896. "I have just learned of the height of the barometer, within a reasonable degree of accuracy, in or very near the center of the track of the tornado at the time it moved through Lafayette Park. It was in this park that the storm was at its height. An aneroid barometer, with a metrical scale, was brought to me to be reset, and I was informed that it was the property of the widow of the late Richard Klemm, ex-Park Commissioner of this city. The family live on Missouri Avenue, immediately fronting the park, and a son of Mr. Klemm read the barometer as the storm struck their place. He called the attention of his mother to the remarkably low reading, 680 mm., or 26.78 inches. Allowing for difference in elevation and reduction to sea level, this would indicate a reduced reading of 27.30 inches, or 2.05 inches lower than observed at this office."—ED.

6.20 p. m. the direction once more changed, this time to the northeast, with a decided decrease in velocity, falling to 7 miles per hour at 6.55 p. m. After that time it again gradually increased to 36 miles per hour, at 7.23 p. m., when the second heavy fall of rain commenced. At 7.32 p. m. there was another sudden decrease to between 12 and 15 miles per hour, after which time it remained comparatively steady, with a generally easterly direction.

The thermograph was blown over in the shelter a few minutes after 6 p. m., reading 71° at the time. The temperature variations, however, were not marked, a minimum of only 65° being reached at 8 p. m. Heavy rain commenced at 6.04 p. m., continuing until 7.05 p. m., when a still heavier fall commenced, ending finally at 10.05 p. m. The heaviest falls of rain were as follows: Five minutes (from 7.25 to 7.30 p. m.), 0.55 inch; ten minutes (from 7.23 to 7.33 p. m.), 0.66 inch; one hour (from 6.04 to 7.04 p. m.), 1.33 inches.

The general direction of the storm through the city was from west to east [about seven blocks south of the Weather Bureau station], turning slightly to the north of east as it reached the river, and continuing in that direction through East St. Louis into Illinois. The electrical display during the storm was of exceeding brilliancy. It was first observed in the form of sheet lightning in the northwest at 5 p. m. This continued with short intermissions until 5.45 p. m., when it became almost continuous, and extended more into the west and north. Little or none was observed directly in the south. At 6 p. m. the whole west and northwest sky was in a continuous blaze of light, and the reflection could be seen beyond the clouds extending far into the southern sky. Intensely vivid flashes of forked lightning were frequent, being outlined in green, blue, purple, and bright yellow colors against the dull yellow background of the never-ceasing sheet lightning. A peculiar electrical phenomenon was observed at 6.15 p. m. A sharp line of bright, yellow lightning was seen almost directly in the west at an altitude of about 25°, extending thence 5° toward the zenith, which, instead of disappearing as suddenly as it had appeared, moved about 5° toward the south, remaining visible about one second, and maintaining its perpendicular position.

The display of lightning lasted as long as did the heavy rain, but occasional flashes continued to be seen after 10 p. m. The thunder ceased at 9.50 p. m. The green cloud remained in the northwest almost to the end of the storm, but while the violence was greatest large black masses of fracto-cumuli with exceedingly ragged edges, moved from the south, west, and north, crossing each other with great rapidity in the west at an altitude varying from 30° to 70°. No evidences of the tornado funnel cloud were observed, although they were carefully looked for, and thorough inquiry and investigation have failed to produce any.

Grand and magnificent as was the spectacle as witnessed from the Weather Bureau station, it fades into comparative insignificance when contrasted with the wonderful and terrible transformation which was in progress at the same time nearly a mile farther south. Here, in the darkness, was waged the fiercest conflict; scenes appalling in their terror and awfulness were witnessed—a sickening tragedy was enacted, and all the tremendous forces of nature were apparently convulsed in a horrible, mighty, and invincible determination to overthrow and to destroy.

The storm entered St. Louis from the west between the Missouri Pacific Railroad tracks on the north and one or two blocks south of the poorhouse on the south, a width of about 1¼ miles. The time, as nearly as can be estimated from the various reports received, and from comparison with the data at the Weather Bureau Office, was 6.10 p. m.

The path through the city was almost exactly in a due easterly direction, reaching the Mississippi River, about 6 miles distant, at 6.20 p. m., showing a progressive velocity of about 36 miles per hour.

The width of the storm track remained generally the same as it moved eastward until 2d Carondelet avenue was reached, when it narrowed to somewhat less than one mile, and thereafter continued within this limit. When the high ground at Grand avenue and Compton Hill Reservoir was reached the storm apparently lifted so that the district north to Caroline street, and east to California avenue was touched but lightly, except along Lafayette avenue, which was damaged considerably as far west as Compton avenue. This Compton Hill district is about 25 feet higher than the surrounding neighborhood.

The district immediately to the south of the reservoir did not escape, and Russell avenue between the reservoir and California avenue was particularly unfortunate.

There was no evidence of the inward spiral rotary motion of the winds west of California avenue, but in the district east of this avenue, south to Geyer avenue and north to Lafayette avenue, the position of the debris indicated the presence of the whirling motion, and from this section eastward the greatest destruction was wrought,* the width of the path traversed by the whirl remaining the same.

The storm attained its maximum severity in Lafayette Park and the district immediately surrounding. The park is about two blocks square, and was thickly covered with trees, mostly of mature growth. Every tree, except perhaps a dozen small and very pliable ones, was either twisted or broken off, and in some cases uprooted. The bark was also stripped off of many. The debris lay in every direction, showing that the center of the whirl must have passed directly through the park. At the City Hospital, a short distance east of the park, the lower edge of the whirl evidently passed through the northwest half of the grounds where there was nothing but a complete and confused mass of wreckage to be found; while in the southeast half the inner walls were blown out toward the north, and almost all of the outer walls remained standing.

Evidences of gyratory motion become less marked after leaving the hospital, but they are still more or less apparent as the storm moved eastward across the river into East St. Louis, the debris on the north side lying generally toward the south, and that on the south side toward the north.

During the progress of the storm across the city, many who were directly within its limits heard a rumbling noise similar to that made by a long train of cars while passing through a tunnel. No unusual noises, however, were heard at the Weather Bureau station. A very noticeable characteristic of this storm was the comparatively uniform height of its lower edge above the ground, the distance being about 30 feet, rarely more or less. In a great majority of the houses which were struck the damage was above the first floor, except in the cases of collapse in the center of the track, and of crushing of lower floors by the weight of debris falling from above. Hundreds of walls were blown out above the first floors, while the lower walls remained practically intact. In Lafayette Park nearly all of the trees were broken or twisted off at an elevation of about 30 feet. Numerous other evidences of this uniform height were also observed.

The evidence of unusual heat which often accompanies tornadoes was observed at only one place, Lafayette Park. Here many of the branches and twigs bore signs of having been seared, as if by a hot iron. [Also noted in the Sherman, Tex., tornado.—ED.]

*This is in accordance with theory. The progressive motion of the general storm was a little south of east with a considerable velocity. This motion combined with the gyratory velocity of the winds on the southeastern side of the whirl would produce a much greater resultant velocity than on the left-hand side where the general drift of the storm and the gyratory motions were more or less in contrary directions.—ED.

Much damage appears to have been caused by great differences in the atmospheric pressure within very limited areas, creating, as it were, numberless small secondary whirls. For instance, single stones and bricks were taken out of walls. A wagon loaded with lumber and having two horses attached was standing near the river; the wagon was not even overturned, while the horses were carried away. In numerous instances the walls of a house would be blown outward, while its neighbor escaped practically untouched. Of course, in cases of this latter description, due allowances must be made for differences in construction, but in many instances this factor would be of minor importance. Another point noticed was that in the storm track, whenever an opportunity was afforded to more or less equalize the pressure between the insides and outsides of structures, the damage was proportionately less than where there was no such opportunity. This was remarked in some houses where the windows had been left open, and also in others roofed with slate or shingles when compared with those roofed with tin. A patch of slate or shingles would be torn away, allowing the air to escape from within, and the remainder of the roof would escape injury. Not so, however, with tin roofs; being of one piece and more securely fastened, they were entirely taken away.

It was noted also by comparison with the data at other points that the storm increased in intensity as it entered St. Louis, and again decreased after it left East St. Louis. The immense increase of surplus heat which had been stored in the walls and streets of the city during the seven weeks previous, combined with that liberated by the heavy rainfall, may have contributed to this. As the storm left the city for the open country, its supply of fuel was greatly decreased, resulting in a corresponding loss of energy.

Regarding the actual intensity of the storm, there has been much difference of opinion, particularly among architects, civil engineers, and others whose opinions are of value. Many insist that no structure in the city could have withstood the full force of the tornado, and point to the disaster at Lafayette Park and the St. Louis bridge as confirmations of their theory. The evidence afforded by the park is probably satisfactory proof, but not so that afforded by the St. Louis bridge. Here some of the heavy masonry on the south side of the East St. Louis approach was torn away, but it is extremely difficult to believe that it was done by direct application of air pressure. Competent and experienced engineers have assured me that the masonry on this bridge, supported as it was above and below, could withstand a pressure of at least 2,000 pounds to the square foot. The pressure per square foot on an absolute vacuum at sea level is only about 2,100 pounds, and it is not reasonable to suppose that even in the very center of the tornado whirl did anything approaching a perfect vacuum exist. Consequently pressure alone, or even pressure combined with a twisting motion, could not have produced the damage to the bridge. Probably the correct solution of the matter is that the supports were first torn out and then the unsupported columns of masonry were not sufficiently strong to withstand the pressure. Consequently they were blown down. If the supports had remained intact, there would have been no damage done to the columns.

In other portions of the city the greater part of the damage was unquestionably due to comparatively weak construction. In the vicinity of Lafayette Park, where most of the houses were well built, instances of total destruction were infrequent as compared with those in the districts farther east and in East St. Louis.

Again, instances of heavy bodies, such as roofs, etc., being carried for a considerable distance (a frequent occurrence in tornadoes), were quite rare in this storm. In some instances roofs were pushed over to one side, and in others they simply settled down on the debris or lower walls after the upper ones had fallen or been blown outward. I have heard of none that were carried away. Neither did I hear of any trees being moved more than a few feet.

Probably the most remarkable evidence of the force of the storm was the following:

On the long East St. Louis approach to the St. Louis bridge a white pine plank, 2 by 8 inches, was driven into the south side of a steel girder with such velocity that it punched a hole in the web and remained sticking in the girder.

The tornadoes in St. Louis and East St. Louis were the local manifestations of a series of destructive storms which moved from the eastern portion of Missouri through Illinois during the afternoon and evening of May 27.

The first storms reported were in the southeast portion of Randolph County and the extreme northern portion of Boone County (see Chart VIII), about 125 miles west-northwest from St. Louis.

After leaving Randolph County two tracks appear, one northeastward into Monroe County where it was lost, and the other eastward through Audrain County into the western portion of Pike County; then southeastward through Montgomery and Warren counties to the Missouri River, and thence generally eastward, the next reappearance being in St. Louis County and the extreme eastern portion of St. Charles County. Passing through St. Louis and across the river to East St. Louis, the track appears to have been easterly through St. Clair into Washington and Jefferson counties, with a milder spur northeastward into Fayette county.

Following are brief accounts of the storms in the majority of the places in which they were most severe, the data having been obtained through the courtesy of the postmasters and others interested:

Higbee, Randolph County, Mo.—The storm passed south of the town, about 3 p. m., moving toward the northeast. A funnel cloud was seen and heavy rain fell, with some scattered hailstones of large size. The storm was accompanied by heavy thunder, some lightning, and a roaring noise. A whirling motion was observed, and debris lay in every direction. The width of the path of greatest destruction was about 200 feet. A peculiar brightness was seen in the cloud and two clouds were seen to come together in the west.

Clark, Randolph County, Mo.—The storm passed to the northwest of the town about 3 p. m., moving northeast by east. A funnel cloud was seen and heavy rain fell, with considerable hail, some of the stones being an inch in diameter. The storm was accompanied by continued rolling thunder, but with little lightning, and a roaring noise was heard. A whirling motion from left to right was observed. The width of the path of greatest destruction was from 50 to 100 yards and its length about 6 miles. A slight glow was seen in the cloud, and two clouds were seen to come together in the west.

Renick, Randolph County, Mo.—The storm moved in a northeasterly direction about 1¼ miles south of the town at about 4 p. m. A funnel cloud was seen and heavy rain fell, with some large hailstones also. There was considerable lightning, but very little thunder, and a roaring noise was heard. There was also a whirling motion from left to right. The length of the path of greatest destruction was 4 or 5 miles. The clouds had a greenish appearance, and two were seen to come together in the west.

Sturgeon, Boone County, Mo.—The storm passed about 4½ miles north of the town about 4 p. m., moving from the northwest toward the southeast. A funnel cloud was seen, and heavy rain, with some light hail, fell after the storm. There was heavy thunder, with vivid lightning, and a roaring noise was heard. A whirling motion from left to right was observed, and the debris fell some to the east and some to the west. The width of the path of greatest destruction was about 200 feet, and its length about 3 miles. A peculiar glow of brightness was seen about the clouds, and two were seen to come together in the west.

Mexico, Audrain County, Mo.—The storm moved toward the northeast, passing about 5 miles north of the town about 6 p. m. A funnel cloud was seen, and there was heavy rain, most abundant after the storm. There was also hail, with stones of irregular shape, some of them weighing 7 or 8 ounces. A roaring noise was heard, and a whirling motion from left to right was observed. The debris all fell toward the northeast. The width of the path of greatest destruction was one-fourth of a mile.

Vandalia, Audrain County, Mo.—The storm passed on the west side of the town about 3.35 p. m., moving from the northwest toward the southeast. No funnel cloud was seen, and there was very heavy rain,

most abundant after the storm. There was very little hail and not much thunder. A roaring noise was heard, and there was an apparent whirling motion from left to right. The width of the path of greatest destruction was about 100 yards, and its length 1 mile. Two clouds were observed to come together in the west.

Curryville, Pike County, Mo.—The storm moved over the town from the northwest toward the southeast at about 3.50 p. m. No funnel cloud was seen, but, as it was very dark during the high wind, it might have escaped observation. Six inches of rain fell. It was very heavy during the high wind, and for thirty minutes after. There was little or no hail. There were but few peals of thunder, but they were terrific, and were so low that they seemed to be on the ground. A roaring noise was also heard. On the north side of the track the debris fell toward the northeast (?), and on the south side toward the southwest (?). In the center it lay in every direction. The width of the path of greatest destruction was about 1½ mile, and its length about 8 miles, very heavy for 4 miles and lighter over the remaining 4. The clouds were very dark and low and appeared to be going in every direction. Two came together in the west.

High Hill, Montgomery County, Mo.—The storm passed north of the town about 5 p. m., moving toward the southeast. It was impossible, on account of the darkness, to observe whether there was a funnel cloud or not. Heavy rain fell, but no hail. The thunder was terrific, and vivid lightning was seen in the west. A roaring noise was also heard. The debris fell in every direction. The length of the path of greatest destruction was 6 or 7 miles. The clouds were black and green, and came from all directions.

Washington, Franklin County, Mo.—The storm passed near and through the southeast portion of the town about 5.40 p. m., moving from the southwest toward the northeast. A funnel cloud was seen. The rainfall was light before the storm and heavy after. Some hail the size of marbles fell. There was considerable lightning and thunder, and a roar was heard. A whirling motion from left to right was observed. The debris on the north side of the track fell toward the southeast; that on the south side toward the northeast, and that in the center due east. The width of the path of greatest destruction was three-eighths of a mile, and its length at least 15 miles. The clouds had a blue, sandy appearance, and they parted west of the town, one going north and the other south. The latter caused the most damage.

Chamois, Osage County, Mo.—The storm passed southeast of the town about 6.15 p. m., moving toward the northeast. A funnel cloud was seen, and there was heavy rain and hail, the hailstones being as large as hens' eggs. There was some thunder but not very heavy, and a roaring noise was heard. The debris fell toward the northeast on all sides of the track. The width of the path of greatest destruction was 150 yards and its length 5 miles. Two clouds were seen to come together in the west.

Clayton St. Louis County, Mo.—The storm passed over the town at 6 p. m., moving toward the southeast. No funnel cloud was seen. Heavy rain fell during the storm but no hail. There was no whirling motion observed, and debris in the center of the storm track lay toward the southeast. The width of the path of greatest destruction was 1 mile and its length 8 miles. A peculiar brightness was seen in the clouds, and two were observed coming together in the northwest about 5 miles distant.

Mascoutah, St. Clair County, Ill.—Two storms passed over the town at 6.45 p. m., one moving from the southeast, and the other from the northwest. No funnel cloud was seen, and heavy rain fell, being most abundant after the storm. Some hail but not heavy, also fell 6 hours after. There was a little lightning, and a roaring noise was heard before the storm. No whirling motion was observed, but debris lay in all directions. The width of the path of greatest destruction was nearly 1 mile, and its length 1½ miles. Before the storm a glow was seen in the clouds, and two came together just west of the city.

Richview, Washington County, Ill.—The storm passed north of the town at 8 p. m., moving a little south of east. No funnel cloud was seen, and rain fell most abundantly after the storm. Thunder and lightning were terrific and almost continuous. A roaring noise was heard, but no whirling motion was observed. Debris lay in every direction but mostly toward the east. The length of the path of greatest destruction was about 5 miles. The cloud was first green above and yellow below, and was quickly followed by a heavy black cloud from the southwest.

Mount Vernon, Jefferson Co., Ill.—The storm passed about 5 miles north of the town at 9 p. m., moving east-southeast. A funnel cloud was seen. The rain was very heavy, 2.85 inches, and heaviest during the storm. No hail was seen. The thunder was very heavy, and the electrical display very brilliant. A roaring noise was heard, and a whirling motion observed, the debris lying in every direction. The width of the path of greatest destruction was from one-fourth to 1 mile. There was no bright cloud, and no meeting of two clouds in the west.

Recapitulation.

Place.	Lives lost.	Value of property destroyed.
St. Louis, Mo	137	$10,239,000
East St. Louis, Ill	118	2,000,000
St. Louis County	.....	100,000
Curryville, Mo	1	90,000
Audrain County, Mo	6	.....
High Hill, Mo	1	.....
Washington, Mo	1	15,000
Chamois, Mo	2	200
Clayton, Mo	1	5,000
New Baden, Ill	13	.....
Birkner, Ill	8	.....
New Minden, Ill	11	200,000
Harmony Station, Ill	2	.....
Mascoutah, Ill	1	125,000
Germantown, Ill	1	.....
Richview, Ill	1	10,000
Jefferson County, Ill	2	.....
Clark, Mo	.....	3,500
Renick, Mo	.....	22,000
Sturgeon, Mo	.....	200
Mexico, Mo	.....	50,000
Vandalia, Mo	.....	45,000
Total	306	12,904,900

REMARKS BY THE ACTING EDITOR.

The meteorological conditions attending the tornadoes of May 27, 1896, were charted and described in Storm Bulletin No. 4, 1896. Subsequent reports show that the area of what may be termed thunderstorm conditions was of very considerable extent, embracing the whole of the States of Iowa and Missouri, the greater portion of Illinois, and extending eastward and southeastward into Kentucky, Tennessee, and West Virginia. The path of greatest destruction, or the region within which the tornado formation occurred, is shown on Chart VIII. It must not be conceived that a single tornado or even a number of tornadoes, passed over the area inclosed between the heavy lines on Chart VIII, but rather that tornadic action was developed successively at different points in the track of the general storm. The latter apparently belonged to a class of summer thunderstorms which move broadside in a southeasterly direction through the States of the central Mississippi Valley, generally dying out at nightfall.

At a number of places within the path of greatest violence, severe thunderstorms only were experienced, but even these frequently cause destruction of life and property, especially in cases of unfinished structures and buildings of weak construction.

The St. Louis tornado, when compared with tornadoes that have occurred in other sections of the country, does not appear to have been extraordinarily violent. The loss of life was relatively small, considering the very great opportunity that was presented. The Louisville tornado, with a path of only 300 yards in width, caused the destruction of 76 lives and a property loss of $2,500,000.

It is only within the last few years that an opportunity of observing the effect of a tornado on one of the larger cities has been offered, and only quite recently that anything approaching a complete record of the various meteorological elements during the passage of a tornado, has been secured. The records made by the automatic instruments at the St. Louis station are given on Chart IX, to which has been added a copy of the barograph trace at Little Rock, Ark., during the passage of a tornado over that city in October, 1894. There have also been added barograph curves at Rochester, Albany, New York, and Philadelphia during the passage of what might be called thunderstorms and incipient tornado conditions during September 17, 1895. The New York observer remarks in this connection:

Evidence of tornadic action was observed to the east of station between 9.10 and 9.20 a. m. There was a bank of dark clouds in great confusion moving, apparently, from the south; distinct formation could not be fully observed on account of the dense fog that prevailed at the time.

The agreement between the two pressure curves, Little Rock and St. Louis, is very striking, and tends to confirm the theory that there is a partial vacuum or core of greatly diminished pressure at the center of the tornado vortex, caused by the centrifugal force of the gyrations. The marked oscillations of pressure after the passage of the tornado are also important as evidence of the greatly disturbed equilibrium of the atmosphere and the gradual return to normal conditions.

The amount of pressure fall in the vortex is still unknown, and, from the nature of the case, will probably always remain so. The Weather Bureau office in St. Louis, where the fall of pressure at the moment of the tornado's passage was one-third of an inch, was probably three-quarters of a mile from the center of low pressure. The sudden removal of one-third of an inch of pressure, as measured by the mercurial barometer, corresponds roughly to a pressure of 22 pounds per square foot of surface. This must then be an approximation to the force exerted by the expansion of air of ordidary density confined within buildings in the neighborhood of the Weather Bureau office. The explosive force in the tornado's path was of course vastly greater than on either side, but we have no means of measuring its intensity, unless we accept the reading of the aneroid referred to in Mr. Frankenfield's note of June 23. Further details as to the condition of the aneroid before and after the tornado will be obtained if possible, and published in a subsequent REVIEW.

It is regretted that a record of the direction of the wind at less intervals than five minutes can not be obtained. In reading the record of direction on Chart IX it should be remembered that the directions given are those that prevailed for an instant of time only at 5-minute intervals. Southeasterly winds prevailed from 2 to 5.40 p. m., there being not the slightest variation from that direction. These winds again reappeared at the surface after the tornado had passed, viz, from 6.55 to 7.15 p. m., and again from 9.25 to 10.05 p. m. Thereafter, until 1.30 a. m. of the 28th, the winds were southerly or southwesterly. From 1.30 a. m. until noon of the 28th, the winds were generally northwesterly, occasionally backing to westerly. It may be of interest to note that the southeasterly winds and the oscillations of the barometer ceased at the same time. The velocity record is quite similar to that of a thunderstorm or squall wind. In the Louisville tornado the maximum velocity was but 36 miles per hour, although the tornado path was less than 600 yards from the Weather Bureau office. The wind was also quite moderate on either side of the Sherman tornado. The fact that the greatest damage was done to upper stories, and that there seemed to be a limit below which the force of the tornado was not felt, was also noticed in the Louisville tornado.

The ordinary funnel cloud seems not to have been fully developed in either the St. Louis or Louisville tornado. In the Sherman, Tex., tornado of May 15, 1896, the tornado cloud was seen and accurately described by several persons. The following from an interview with Prof. A. Q. Nash, of the Sherman Institute (Globe Democrat, St. Louis, May 22 1896), is so clear and explicit as to the updraft and the whirling motion that it is here reproduced:

When the cloud passed in front of me it seemed to be going at the speed of a galloping horse. The speed was not so great but that almost any one running to the east or to the west could have got out of the way. The cloud swelled out above the ground, but the top of it was higher than the sides. It seemed to be churning up all that it touched and throwing out the fragments at the top. The shape and action was much like a geyser. At the same time, as it moved along, the mass had a rotary motion. It whirled round and round in a direction from right over to left, just the reverse of the movements of the hands of a watch.

Only the outlines of the mass could be distinguished. It was impossible to see into it. Houses and other things went up as the cloud reached them, disappearing in the revolving interior. At the top and around the edges I could see things whirling and then falling as they got beyond the edges. The revolving velocity was so great it set the adjacent air in motion, and the lighter things, such as leaves and twigs, and bits of pine and particles of mud, circled far outside of the cloud and fell at considerable distances from the path of the cyclone. In the short time I stood there watching the cloud pass I was covered with mud and drenched with muddy water. As the cloud passed the rotary motion could be seen very plainly in the rear.

The path of greatest destruction in the St. Louis tornado extended from Randolph County, Mo., to Jefferson County, Ill., a distance of about 200 miles. After leaving St. Louis a score or more of towns and villages was passed over and 39 lives were lost before the fury of the storm abated.

The scene of tornadic activity was transferred on the following day to southern-central und southeastern Pennsylvania. The center of the general storm was over the lower Lakes, but it will be observed that the region of tornadoes maintained the same relative position to the storm center as on the previous day. The first appearance of a tornado on the 28th was at Columbia, Pa., at 1.30 p. m. One person was killed and 20 injured by the wrecking of a large rolling mill. An eye witness of the storm, Mr. T. L. Urban, describes its approach as follows:

* * * Approaching the window and looking to the northwest I beheld a black cloud, like a great monster about to leap into the river, when, like a flash, and to my surprise and horror, it lifted its colossal form from the bosom of the water in a rotary form. Propelled by the cyclone force it neared the shore; then began the most appalling sight it has been my province to witness. * * * Spellbound I gazed at its approach whirling round and round with a roaring noise, water and mud in advance. It struck the shore, when the black cloud seemingly shot upward, and beneath it I beheld the air filled with flying objects; one huge black mass seemed coming directly towards me. * * * In a whirlwind form it came directly towards me, when to my agreeable surprise on reaching the railroad it took a south, thence southeasterly, course and continued on, leaving in its wake desolation and destruction.

After leaving Columbia the tornado appears to have spent its force, although severe winds and thunderstorms were experienced to the northeastward as far as Easton. A second series of tornadoes swept through Montgomery and Bucks counties to the New Jersey line. Four people were killed and the property loss was quite large. A third series appears to have passed through southern New Jersey, but no lives were lost and the damage was confined principally to the destruction of fences, outbuildings, and barns.

NOTE BY THE CHIEF.

Certain interviews with Prof. H. A. Hazen, U. S. Weather Bureau, have recently appeared in the public press, in which the planting of forests on the southwestern edge of cities and the discharge of dynamite bombs have been advocated as a protection against tornadoes.

It should be clearly understood that the Weather Bureau—using that term as expressing the collective thought of its Chief and members of the scientific staff, Professor Hazen alone excepted—does not indorse the theories set forth in the interviews above referred to. The opinions expressed and the methods of executing them are Professor Hazen's, and he alone is responsible for them.

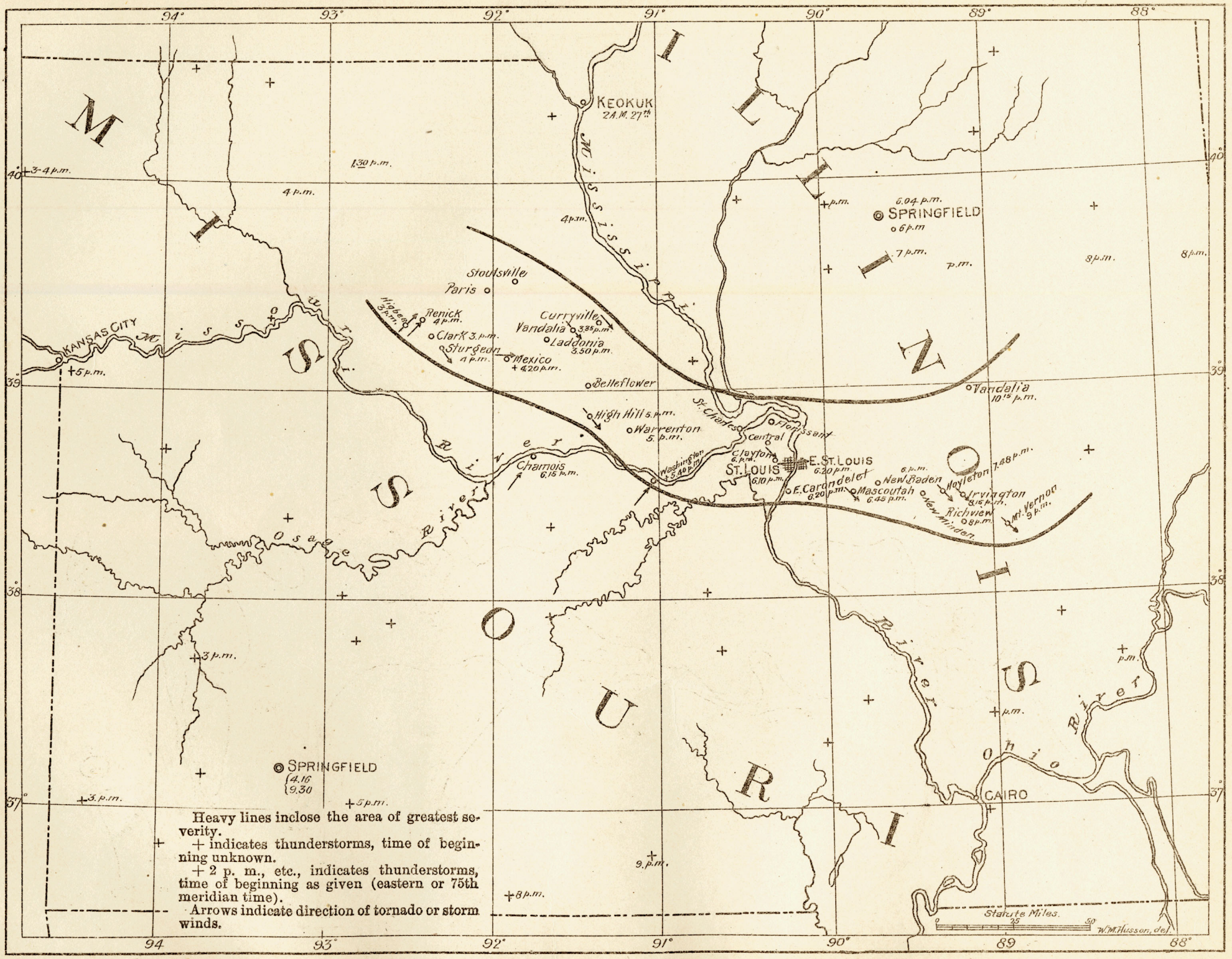
That there may be no misunderstanding in the matter, the following letter has been sent to the managing editors of the various journals that have commented upon the interviews above mentioned:

"I have to inform you that these statements were not authorized by the Weather Bureau, and that the theories advanced are not held by scientific men generally. The interview came from Professor Hazen as a private individual, and not in his capacity as an official of this Bureau.

"From personal observation of the havoc wrought by several tornadoes, I am fully convinced that any attempt to destroy them by the means suggested will be a failure."

June 24, 1896. WILLIS L. MOORE.

Chart VIII. Track of Tornadoes through Missouri and Illinois, May 27, 1896.



Heavy lines inclose the area of greatest severity.

+ indicates thunderstorms, time of beginning unknown.

+ 2 p. m., etc., indicates thunderstorms, time of beginning as given (eastern or 75th meridian time).

Arrows indicate direction of tornado or storm winds.

Chart IX. Records of Automatic Instruments.